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POWER STABILIZATION METHOD FOR A SYNCHRONOUSLY PUMPED DYE LASER--ETC(U)
JAN 81 R E RUSSO, R WIGTNELL, G M HIEFTJE N00014-76-C-0838

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The average power stability of the synchronously pumped dye laser can be improved by a factor of more than 5 by altering the optical feedback stabilization circuitry of the conventional laser system. Noise fluctuations in dye laser output power which normally occur are largely eliminated by changes in the pumping power of the ion laser. The slight loss in dye laser output power which is incurred by the beam splitter ~~(cf Fig. 1)~~ is largely offset by an increase in available ion laser power.

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TECHNICAL REPORT NO. 33

POWER STABILIZATION METHOD FOR A SYNCHRONOUSLY PUMPED DYE LASER SYSTEM

by

R. E. Russo, R. Withnell, and G. M. Hieftje

Prepared for Publication

in

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The mode-locked, synchronously pumped dye laser has become widely used as a tunable light source for picosecond spectroscopy (1-4). It is capable of producing transform-limited pulses as short as 0.3 ps (5), and offers better reliability and tunibility than other sources of picosecond and sub-picosecond pulses (6,7). The early problems associated with this source (e.g. temperature and modulation stability) have been practically eliminated through careful environmental control and proper component selection (8).

In our laboratory, we employ such a laser to examine subnanosecond fluorescence lifetimes of atoms in closed vapor cells and in analytical flames and plasmas. Unfortunately, in these applications power variations in the dye laser output (approximately 5%) have been intolerably large. This manuscript describes a convenient opto-electronic feedback system which can improve the laser's power stability to better than 1%, an improvement of greater than five-fold over the commercial system. Conveniently, the optical feedback network configured for our particular system (Spectra-Physics Model 171-06 argon-ion laser with model 375/341 synchronously pumped dye laser) can be fashioned from components normally supplied to stabilize the argon laser. For such a system, it is necessary only to remove from the ion laser cavity the photocell ordinarily used for feedback stabilization and rearrange it to monitor instead output power from the dye laser. Feedback control to the ion laser power then compensates for instabilities which would otherwise exist at the dye laser output.

The experimental arrangement used in our laboratory to stabilize the synchronously pumped dye laser is shown in Figure 1. In this arrange-

ment, the photocell ordinarily used to stabilize the argon-ion laser power in "light control" mode is detached from its mount and affixed to a stand which allows it to view a portion of the dye laser output beam. The feedback stabilization circuitry in the ion laser then monitors the dye laser power and compensates for any variations in it by altering ion laser current. In this way, 0.8% (rms) stability in the dye laser output power has been achieved. Slight losses in usable dye laser power incurred by the beam splitter in (cf Fig. 1) this approach are largely compensated by a 2% increase in available pump power as a result of removing the photo cell from the ion laser beam.

To achieve the greatest stability in dye laser output, a variable neutral density filter is placed in the monitored beam path to reduce the power level reaching the feedback photocell. In this way, the most sensitive scale (hightest gain) in the ion laser feedback system can be employed. Of course, when this approach is used, the scale reading on the integral power meter usually used to monitor ion laser power level becomes inaccurate and serves only as a relative indication of dye laser output power. Consequently, we employ an independent power meter (Model 36-001 disc calorimeter with Model 36-2001 power indicator, Scientech, Inc., Boulder, CO) to record power level and stability in either the ion or dye laser.

When the feedback-stabilized dye laser is initially configured, it is important to optimize laser output power and pulse stability in the open-loop (current control) mode before the optical feedback (light-control) is implemented. In the feedback configuration ion laser extinction or

substantial power changes in dye laser output caused by dye jet fluctuations can result in large excursions in feedback-controlled ion laser current. Of course, large excursions from the command value might drive the ion laser to its maximum, but for modern laser designs, such changes are not damaging or inconvenient because of built-in protection circuitry.

It is useful to mention a problem which sometimes exists with the feedback network used in the commercial argon-ion laser employed in the present study. For this laser, a beamsplitter in the output mirror housing directs two diverging beams onto the photocell used for power stabilization. Because of the diameter of the beams and their angle of divergence, each strikes a different portion of the photocell, although neither beam is intercepted completely. Therefore, vibrations in the laser or thermal changes in the photocell mount cause the light to move slightly on the active area of the detector and produce an apparent change in the ion laser power. As a result, the plasma tube current is improperly altered, resulting in instability of the true laser output. In our system this problem is overcome by mounting the light control photocell outside the ion laser and directing only one beam onto the center portion of the photocell active area. As a result, the stability specification of the manufacturer could be readily achieved.

In conclusion, the average power stability of the synchronously pumped dye laser can be improved by a factor of more than 5 by altering the optical feedback stabilization circuitry of the conventional laser system. Noise fluctuations in dye laser output power which normally occur are largely eliminated by changes in the pumping power of the ion laser.

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The slight loss in dye laser output power which is incurred by the beam-splitter (cf Fig. 1) is largely offset by an increase in available ion laser power.

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FIGURE LEGEND

Figure 1: Experimental design for stabilization of synchronously-pumped dye laser power.

PM — power meter

PD — photodetector

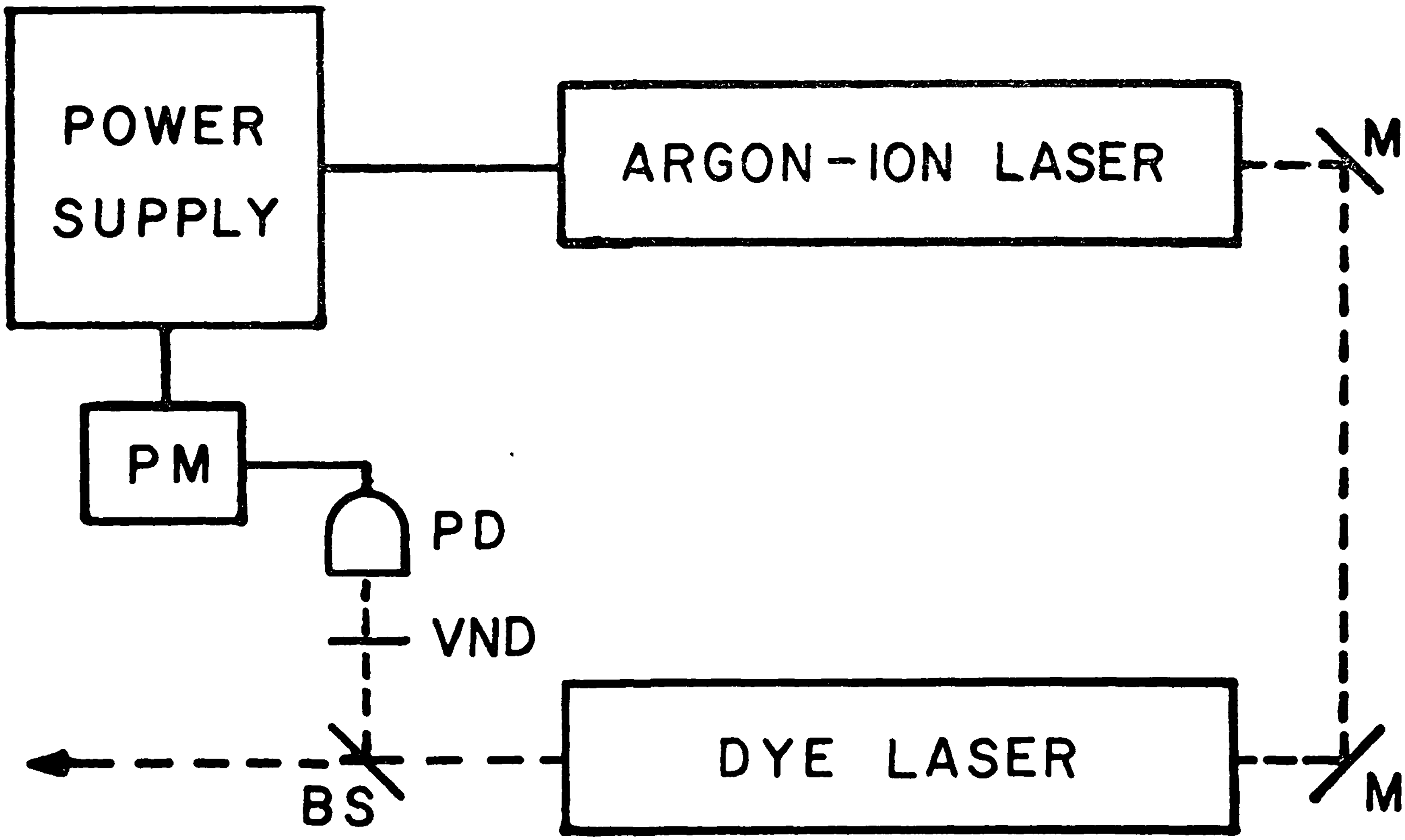
VND — variable neutral density filter

BS — beam splitter

M — mirror

Solid lines (—) electrical connections

Dashed lines (---) laser light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